



Ohio Per- and Polyfluoroalkyl Substances 2018 Sampling Report

Final

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Contents

1.	Introduction.....	1
2.	Study Objectives	1
3.	Sampling Overview	2
3.1	Sampling Area	2
3.2	Sampling Approach	2
3.2.1	Surface Water Samples along State Routes	4
3.2.2	Soil Samples along State Routes	4
3.2.3	Soil Samples within State Lands	4
3.2.4	Surface Water and Sediment Samples within State Lands	5
3.2.5	Plant Tissue Samples within State Lands	5
3.2.6	Fish Samples	5
4.	Sampling Methods.....	5
4.1	Site Characterization	5
4.2	Soil Collection for Chemical Analysis and Soil Characteristics	5
4.3	Surface Water Collection for Field Parameter and Chemical Analysis	6
4.4	Sediment Collection for Chemical Analysis	6
4.5	Plant Tissue Sample Collection	7
4.6	Fish Tissue	7
4.7	Analysis of Samples	7
4.8	Changes to Sampling Protocols	7
5.	Results	8
5.1	Soil	8
5.1.1	PFOA Results	8
5.1.2	GenX Results	15
5.1.3	Soil Physical Characteristics	15
5.2	Surface Water and Sediment	17
5.2.1	PFOA Results	17
5.2.2	GenX Results	23
5.3	Plants	25
5.3.1	PFOA Results	25
5.3.2	GenX Results	25
5.4	Fish	25
5.4.1	PFOA Results	25
5.4.2	GenX Results	26
5.5	Quality Assurance	26
5.6	Data Validation	26
	References.....	26

Appendices

A.	Field Notes and Datasheets.....	A-1
B.	Analytical Laboratory Reports	B-1
C.	Data Validation Report	C-1
D.	Photographs of Sampling Sites	D-1
E.	Full Analytical Laboratory Data Package, Analytical Laboratory EDDs, and Validated EDDs (electronic)	E-1
F.	Photographs from Sampling (electronic)	F-1
G.	2018 Sampling Database (in Access; electronic)	G-1

1. Introduction

Abt Associates (Abt) conducted field sampling in November 2018 to help characterize the spatial extent and degree of per- and polyfluoroalkyl substances (PFAS) contamination in Ohio natural resources related to releases from the Washington Works facility, in Parkersburg, West Virginia.

This report provides a summary of the approach for sampling soils, surface water, sediments, and biota in Ohio near the Washington Works facility; and presents the results from the analyses conducted on field-collected samples. A description of the study objectives is provided in Section 2, the sampling area and Abt's sampling design and approach for site selection are described in Section 3, environmental sample collection methods are presented in Section 4, and Section 5 provides the laboratory analytical results for the various media.

The report contains multiple appendices with supporting documentation for the field effort. A scanned copy of all field notes and datasheets are provided in Appendix A; analytical laboratory reports are provided in Appendix B; the data validation report is in Appendix C; photographs of each sampling site are provided in Appendix D; the full electronic data package, including analytical laboratory reports, electronic data deliverables (EDDs), and validation reports are provided electronically as part of Appendix E; photographs from the sampling trip are provided electronically as part of Appendix F; and a separate relational Access database that contains the field and analytical data is provided electronically as part of Appendix G.

2. Study Objectives

The main objective of this study was to collect soil, surface water, sediment, and biota samples to characterize the spatial extent and degree of PFAS contamination in the State of Ohio related to emissions from the Washington Works facility.

Specifically, Abt:

- Collected soil samples along State Routes and within Ohio Department of Natural Resources (ODNR)-managed State lands.

Note: All soil samples collected along State Routes were collected at a depth of 1 foot or less using small hand shovels. Within ODNR-managed State lands, generally two soil samples were collected at each site targeting a depth of 1 foot and 4–5 feet.

- Collected surface water samples from locations where State Routes cross lakes, streams, or rivers.
- Collected co-located surface water and sediment samples from State lands.
- Collected samples of plant tissue in select State lands.
- Analyzed samples of fish tissue collected by ODNR in Veto Lake.
- Collected pH, specific conductivity, and water temperature measurements from surface water sampling locations to characterize water quality.

3. Sampling Overview

In this section we provide our sampling approach for the November 2018 field sampling effort, including a description of the study area and our approach for selecting sampling sites and sampling locations within the study area. Sampling was conducted in accordance with the Sampling and Analysis Plan (SAP; Abt, 2018), which provides a Quality Assurance Project Plan (QAPP), a Health and Safety Plan (HSP), Standard Operating Procedures (SOPs), and permits obtained for this field effort.

3.1 Sampling Area

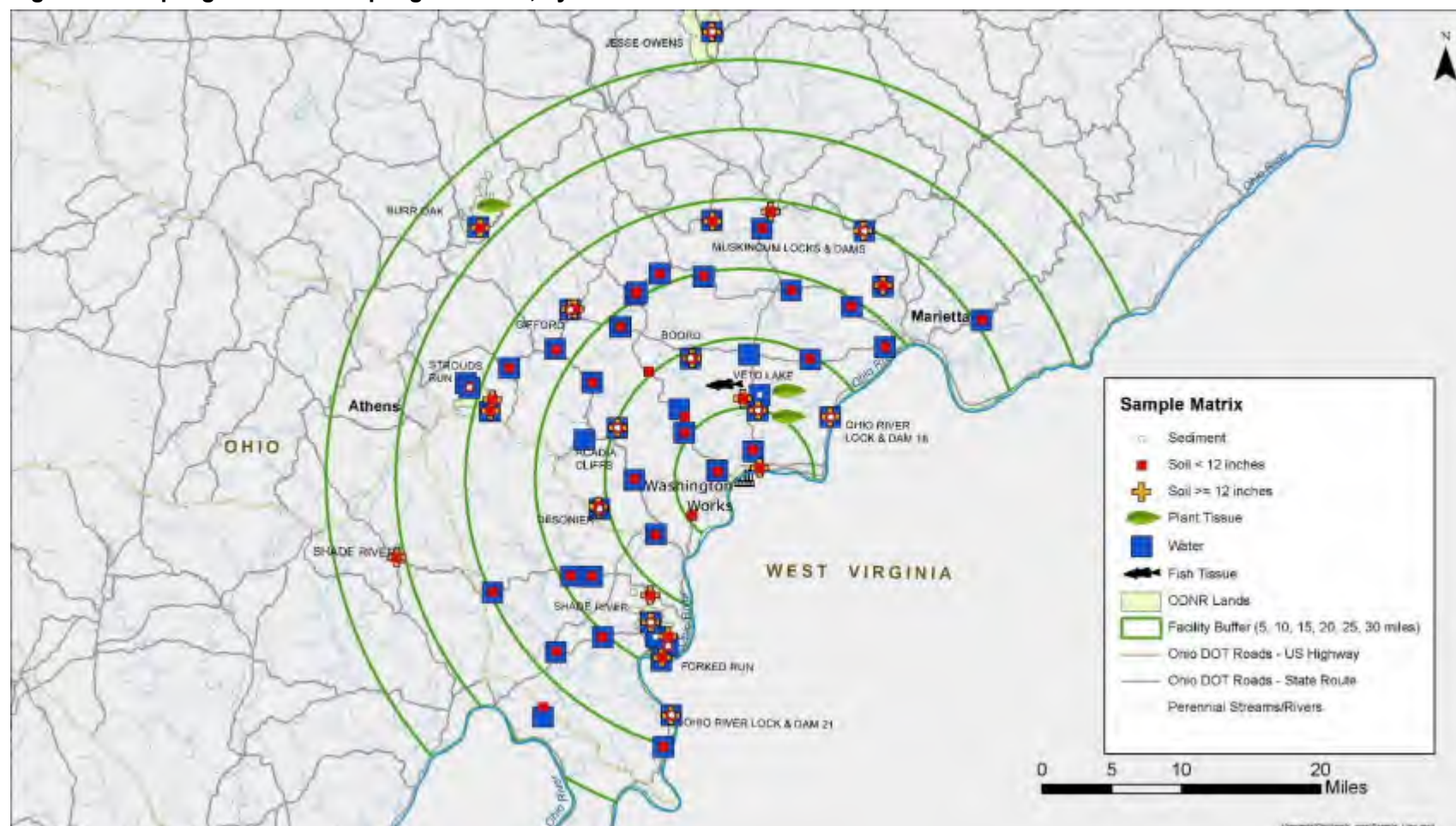
For this project, our study area was defined as the area within approximately a 20-mile radius of the Washington Works facility in the State of Ohio (Abt, 2018; Figure 1). In addition, we collected samples from three locations greater than 25 miles away to serve as possible reference areas. These locations included Shade River (West) State Forest, which is approximately 26 miles southwest of the facility; Burr Oak State Park, which is approximately 26 miles northwest of the facility; and Jesse Owens State Park, which is approximately 32 miles north of the facility (Figure 1). This sampling effort included 104 sampling locations and a total of 171 samples of all media (Table 1). As much as possible, our sampling sites were distributed across the study area, similar to a systematic random sampling approach; however, given that much of our study area is private property, site access limited our ability to sample in certain areas. We collected samples from Ohio State lands such as State Parks, Nature Preserves and Wildlife Areas, and State Forests where we gained permission to sample. These properties are managed by ODNR, and thus, Abt coordinated with ODNR area managers for site access. In addition, we sampled within the right-of-way along two-lane State Routes within our study area. In Ohio, the right-of-way is defined as 30 feet from the road center line, which is approximately 20 feet from the edge of a typical two-lane road.

Table 1. Summary of environmental samples collected in 2018

Matrix	Location type	Count of samples
Soils	State lands and State Routes	85
Surface water	State lands and State Routes	58
Sediment	State lands	18
Fish	Veto Lake (bass livers and fillets)	3
Plants	State lands	7

3.2 Sampling Approach

Our sampling sites are shown in Figure 1. Occasionally, a decision was made in the field not to sample a potential site because of access or safety concerns. For example, along State Routes we did not sample at sites if the field team could not find a safe place to pull off the road or if a suitable location could not be identified. All soil sampling occurred at locations with proper permissions from the Ohio Utilities Protection Service (OUPS) and the Oil & Gas Producers Underground Protection Service (OGPUPS). Additional details on sampling site and sampling location selection for different sample types are described below.

Figure 1. Sampling area and sampling locations, by media.

3.2.1 Surface Water Samples along State Routes

Surface water samples were collected at select locations where two-lane State Routes intersect streams, rivers, or other water bodies within the study area (see Figure 1), as these are areas where the field team could access the water within the State Route right-of-way. A surface water sample was collected at a site if the field team could completely and safely pull off of the roadway and reasonably and safely access the surface water to collect a grab sample. In general, the field team sampled surface waters from the upstream side of the bridge within the right-of-way; however, if access to the water was limited, the field team leader could decide to collect a sample downstream of the bridge within the right-of-way. When possible, surface water samples were collected by directly immersing the sample bottle into the water, without the use of a secondary container. In some cases, it was not possible to safely access the water from the bank, and a decontaminated secondary container on a pole was used to collect a water sample, which was then transferred to a sample bottle. The field staff targeted the surface of the water column (i.e., sampling water depth of 0 feet), and did not disturb sediments while collecting surface water samples.

3.2.2 Soil Samples along State Routes

Soil samples were collected from within the right-of-way along two-lane State Routes. The sampling teams attempted to locate a suitable soil sampling location at the same sites they collected surface water samples; however, if a good soil sampling location could not be located, the soil was not sampled and an alternative site was located (if available). Again, we only sampled from a site if the field team could completely and safely pull their vehicle off of the roadway and we had the proper clearance to dig.

To select a suitable soil sampling location at a site, the team considered the following factors to minimize potential effects from the road:

1. Locations were selected as far as possible from the edge of the road and still within the right-of-way. The right-of-way for Ohio State Routes is 30 feet from the center line.
2. Soils were not collected from an area that looked as though it was recently disturbed or was artificially built up as a result of road construction or maintenance.
3. When the road traversed a hill or incline, the sampling location was located on the uphill side of the road.
4. Soil samples were not collected from a ditch or depression along the road. The targeted sampling location was above or even with the road elevation.
5. Where possible, sampling teams collected samples at optimal sampling locations, generally flat areas higher in elevation than the road and 15–20 feet from the edge of the road.

3.2.3 Soil Samples within State Lands

Within State lands, two soil samples were generally collected at each selected site targeting a depth of 1 foot and a depth of 4–5 feet (or a shallower depth if a depth of 4–5 feet could not be reached with hand tools).

3.2.4 Surface Water and Sediment Samples within State Lands

We also collected co-located surface water and sediment samples within State lands. Coordinates for these sites are provided in the 2018 Sampling Database (Appendix G). To find a suitable sampling location for these co-located samples, the field team first identified depositional areas within the stream, river, or lake with fine-grained sediments. Depositional areas were typically found in slow or non-flowing water at the head or tail of side channels, backwaters, and water-filled depressions in the river floodplain. They were also identified by visual observation of fine-grained sediments. Once a suitable sampling location was identified, the team measured water quality parameters and collected a surface water sample first, from an undisturbed area, and then collected a sediment sample.

3.2.5 Plant Tissue Samples within State Lands

Plant tissue samples were collected in two State lands – Burr Oak State Park and Veto Lake Wildlife Area. Our ODNR State Parks and State Nature Preserves permit allowed collection of plant tissues in these areas (Abt, 2018).

3.2.6 Fish Samples

ODNR collected largemouth bass from Veto Lake as part of routine monitoring of fish populations. These fish were frozen and stored in a secure location at the ODNR facility.

4. Sampling Methods

The following sections describe the methods we used to collect soil, surface water, sediment, and biota samples for this study.

4.1 Site Characterization

Sampling sites were characterized using photographs according to the guidelines in the *Video and Photograph Documentation* SOP (Abt, 2018). Photograph documentation of a site included first photographing the global positioning system (GPS) unit, and then photographing the selected sampling location.

The field teams also marked GPS coordinates for each sampling location at a site, recording them on the appropriate datasheet(s), and marked the general location of each sampling site on a printed map of the study area.

4.2 Soil Collection for Chemical Analysis and Soil Characteristics

Along State Routes, the field teams collected soil samples from a depth of 1 foot or less (sampling depths ranged from 4 to 12 inches). At these sites, samples were collected using small hand shovels according to the *Soil Sampling* SOP (Abt, 2018). Within State lands, we collected up to two soil samples at each soil sampling location, one at a depth of 1 foot or less (matching the near-surface sampling conducted along State Routes), and a second sample at a depth of 4–5 feet (deep sample depths ranged from 12 to 49 inches). At two sampling locations, in Jesse Owens State Park and Muskingum Lock and Dam #4, field sampling teams encountered bedrock, or an impenetrable substrate, at a depth of 12 to 18 inches, and samples were collected just above this substrate in these locations.

Soil samples were collected using hand augers (see the *Soil Sampling* SOP for details; Abt, 2018). If the hand auger could not be advanced sufficiently at a sampling location, we collected a near-surface sample at 1 foot or less using hand shovels. If needed, vegetation was removed within a small area (e.g., 0.5–1 foot diameter) to permit soil sampling.

At a subset of sites, shallow (< 1 foot depth) soil samples were collected for the analysis of soil characteristics, including pH, total organic carbon (TOC), and particle size.

4.3 Surface Water Collection for Field Parameter and Chemical Analysis

Surface water samples were collected from select lakes, streams, rivers, and springs within the study area according to the *Surface Water Sampling* SOP (Abt, 2018). Prior to collection of surface water samples, we measured water quality parameters (i.e., pH, specific conductance, and water temperature) at each surface water sampling location according to the *Field Water Quality Parameters* SOP (Abt, 2018). In addition, the approximate water column depth, which is the vertical distance from the water surface to the sediment surface, was recorded. Other habitat characteristics recorded include water clarity/turbidity, substrate type, approximate width of stream, stream flow characterization (riffle, run, pool, etc.), nature of the stream banks (rip-rap, vegetation, eroded, etc.), presence of biota, and any other pertinent observations.

Field duplicate quality control (QC) samples were collected at a minimum frequency of 1 in every 20 sampling locations according to the *Quality Assurance/Quality Control Sample Preparation* SOP (Abt, 2018). Field duplicates were given a unique sample identification (ID) number and submitted “blind” (without any documentation identifying it as a QC sample) to the analytical laboratory. While field teams generally collected water samples by directly filling the sample bottles, in some cases, a secondary container was needed to collect sufficient volumes. If a secondary container was used for more than one sample, it was decontaminated between samples, and the equipment rinsate blank samples were collected at a minimum frequency of 1 in 20 samples collected by the secondary container method. After collection, the water samples were placed into a cooler with wet ice until shipment to the laboratory for analysis.

4.4 Sediment Collection for Chemical Analysis

Sediment samples were collected from State lands at the same sampling locations as surface water samples. All sediment samples were collected after collection of the surface water samples according to the *Sediment Sampling* SOP (Abt, 2018). In brief, sediments were collected with a scoop or coring device to a depth of approximately 4 inches (10 cm). Sediment samples were placed directly into sample jars. Sediments were sieved with a No. 10 mesh sieve at the analytical laboratory before analysis.

QC samples consisted of field duplicate samples and equipment rinsate blanks, which were both collected at a minimum frequency of 1 in 20 sampling locations. See the *Quality Assurance/Quality Control Sample Preparation* SOP (Abt, 2018) for details. Field duplicates and equipment blanks were given a unique sample ID number and submitted “blind” (without any documentation identifying it as a QC sample) to the laboratory. Sediment samples were preserved on wet ice until shipment to the laboratory for analysis. As noted above, all samples were photographed and observations logged according to the *Video and Photograph Documentation* SOP (Abt, 2018).

4.5 Plant Tissue Sample Collection

Plant tissue samples (i.e., tree leaves and cut grass) were collected at two sites: one site close to the Washington Works facility in the Veto Lake Wildlife Area and one site approximately 26 miles away from the facility at Burr Oak State Park. ODNR State Parks and State Nature Preserves provided permits that allowed the collection of plant tissues on these State Lands (Abt, 2018).

4.6 Fish Tissue

Three largemouth bass were collected from the Veto Lake Wildlife Area by ODNR in May 2018 as part of routine fish surveys. These fish were frozen and stored in a secure location at the ODNR facility in Athens, Ohio, and later shipped at Abt's request to ALS Laboratory in Kelso, Washington (ALS). ALS analyzed samples of the liver and fillets from these three fish, including one laboratory duplicate.

4.7 Analysis of Samples

Abt staff sent field-collected samples of soil, sediment, surface water, and plant tissue under chain-of-custody to ALS for sample analysis. ODNR shipped the whole fish from the ODNR facility directly to ALS.

Samples were analyzed for perfluorooctanoic acid (PFOA) and hexafluoropropylene oxide dimer acid (HFPO-DA), also known as GenX. In addition to environmental samples, quality assurance/quality control (QA/QC) samples were collected, including equipment rinsate samples, field blanks, and field duplicates. For field blanks, at least one sample was collected by each sampling team, at the beginning of each day samples were collected. All QA/QC samples were collected as described in the SAP (Abt, 2018) and analyzed for PFOA and GenX.

4.8 Changes to Sampling Protocols

In some instances we were unable to reach the proposed field sampling location due to safety concerns such as proximity to busy roadsides or steep embankments that prohibited access to the stream bank. This occurred most often for surface water sampling locations. Where feasible, we took substitute surface water samples from the same water body if it was more accessible on another nearby road.

For some surface water locations where it was difficult to access the stream bank, we used a surface water sampling device with an extendable arm to reach the water interface and transfer the water sample to the sample container. We decontaminated the sampler, rinsed with PFOA-free water, and then rinsed with site water before every use. We only deployed this sampling device when the bank was inaccessible but the surface-water interface could be reached with the fully extended sampler arm.

On State lands, we attempted to collect both shallow and deep soil samples. In some instances during the deep soil sample collection, the hand auger would reach bedrock, another impenetrable subsurface layer, or the water table. Depending on the depth of these layers, we either sampled from the deepest horizon we could and recorded the depth in our field datasheets, or only collected a shallow soil sample at that location.

At two sampling locations, one in Desonier State Nature Preserve and one in Gifford State Forest, the GPS coordinates were not accurately recorded. For these two sampling locations, the GPS coordinates of the collected samples were estimated by using the coordinates provided to OUPS to get permission to dig at that sampling site.

5. Results

This section presents the analytical results for soil, surface water and sediment, plants, and fish. In each case PFOA results are presented first, followed by a summary of the GenX results.

5.1 Soil

Soil samples were analyzed for PFOA and GenX at 57 locations within the study area. Analytical results are presented for PFOA and GenX on State lands and along State Routes.

5.1.1 PFOA Results

This section presents PFOA concentrations measured in shallow and deep soil samples on State lands and along State Routes.

State Lands

Shallow Soil Sample Results

Concentrations of PFOA in shallow soils on State lands ranged from 330 to 24,000 ng/kg (Table 2). PFOA was detected at every shallow soil sampling location, including at the outer limits of our sampling range, approximately 32 miles from the Washington Works facility in Jesse Owens State Park. While PFOA concentrations in the shallow soil samples generally increased with proximity to the Washington Works facility, we saw concentrations up to 12,000 ng/kg over 17 miles away in Gifford State Forest (Table 3). The highest concentration in shallow soils (24,000 ng/kg) was observed in a sample taken just over 5 miles north of the facility in the Veto Lake Wildlife Area. The sample with the lowest concentration (330 ng/kg) was located in Jesse Owens State Park, approximately 32 miles north of the facility (Table 2).

Deep Soil Sample Results

Analytical results for PFOA in deep soil samples in State lands ranged from below the analytical detection limit (< 190 – 220 ng/kg) to 11,000 ng/kg (Table 2). PFOA concentrations in deep soil samples were generally lower than co-located shallow soil samples (Figure 2). In addition, they generally increased with closer proximity to the Washington Works facility (Table 3). PFOA was not detected in a total of five of the deep soil samples. One of these five samples was located 10.8 miles southwest of the Washington Works facility in Shade River State Forest, and the other four samples were located more than 17 miles from the Washington Works facility. The highest PFOA concentration measured in deep soil samples collected on State lands was 11,000 ng/kg, which was measured in both the Veto Lake Wildlife Area, 5.7 miles north of the Washington Works facility; and Muskingum Lock and Dam #3, 19.7 miles northeast of Washington Works (Table 2; Figure 2).

Table 2. PFOA and GenX concentrations in soils

State land or Route	Date	GPS coordinates		Distance from facility (miles)	Shallow soils				Deep soils			
					Sample #	Depth (in)	PFOA (ng/kg)	GenX (ng/kg)	Sample	Depth (in)	PFOA (ng/kg)	GenX (ng/kg)
State Route 618	11/14/2018	39.280319	-81.654457	1.3	181114-618-SL-211	6	15,000	2,300	181114-618-SL-212	48	4,400	< 1100
State Route 555	11/14/2018	39.276103	-81.711079	2.0	181114-555-SL-210	6	2,900	< 1,000	N/A	N/A	N/A	N/A
State Route 339	11/14/2018	39.299146	-81.663466	2.1	181114-339-SL-214	6	1,200	< 1,100	N/A	N/A	N/A	N/A
State Route 124	11/12/2018	39.230367	-81.744410	4.6	181112-124-SL-112	6	4,100	< 1,200	N/A	N/A	N/A	N/A
State Route 555	11/14/2018	39.316117	-81.754978	5.3	181114-555-SL-207	6	850	< 1,100	N/A	N/A	N/A	N/A
State Route 555	11/14/2018	39.333160	-81.755415	6.1	181114-555-SL-205	6	4,600	< 1,200	N/A	N/A	N/A	N/A
State Route 144	11/12/2018	39.209554	-81.793375	7.6	181112-144-SL-111	8	480	< 1,100	N/A	N/A	N/A	N/A
State Route 144	11/12/2018	39.268022	-81.822276	7.9	181112-144-SL-107	6	2,100	< 1,200	N/A	N/A	N/A	N/A
State Route 144	11/12/2018	39.268024	-81.822279	7.9	181112-144-SL-109	8	5,100	< 1,300	N/A	N/A	N/A	N/A
State Route 550	11/12/2018	39.394350	-81.588295	9.8	181112-550-SL-005	6	680	< 1,100	N/A	N/A	N/A	N/A
State Route 555	11/14/2018	39.379778	-81.804191	10.3	181114-555-SL-202	6	3,200	< 1,300	N/A	N/A	N/A	N/A
State Route 555	11/14/2018	39.379778	-81.804191	10.3	181114-555-SL-203 ^a	6	3,000	< 1,300	N/A	N/A	N/A	N/A
State Route 329	11/12/2018	39.367576	-81.879547	12.9	181112-329-SL-105	6	4,600	< 1,200	N/A	N/A	N/A	N/A
State Route 681	11/13/2018	39.166284	-81.877642	13.0	181113-681-SL-211	6	6,600	< 1,300	N/A	N/A	N/A	N/A
State Route 550	11/12/2018	39.407318	-81.488023	13.8	181112-550-SL-007	6	< 180	< 1,000	N/A	N/A	N/A	N/A
State Route 676	11/12/2018	39.465532	-81.613811	13.9	181112-676-SL-211	6	3,100	< 1,300	N/A	N/A	N/A	N/A
State Route 550	11/12/2018	39.426438	-81.843048	14.1	181112-550-SL-002	6	2,400	< 1,100	N/A	N/A	N/A	N/A
State Route 681	11/13/2018	39.166263	-81.905909	14.3	181113-681-SL-214	6	3,100	< 1,200	N/A	N/A	N/A	N/A
State Route 676	11/12/2018	39.449164	-81.533586	14.5	181112-676-SL-213	6	1,500	< 1,300	N/A	N/A	N/A	N/A
State Route 676	11/12/2018	39.479529	-81.732116	14.8	181112-676-SL-209	6	570	< 1,100	N/A	N/A	N/A	N/A
State Route 248	11/13/2018	39.102685	-81.862775	15.3	181113-248-SL-209	6	3,100	< 1,100	N/A	N/A	N/A	N/A
State Route 676	11/12/2018	39.460932	-81.822523	15.4	181112-676-SL-203	6	5,000	< 1,300	N/A	N/A	N/A	N/A
State Route 676	11/12/2018	39.462801	-81.820594	15.4	181112-676-SL-205	6	2,300	< 1,200	N/A	N/A	N/A	N/A
State Route 676	11/12/2018	39.481330	-81.790872	15.8	181112-676-SL-207	6	2,900	< 1,200	N/A	N/A	N/A	N/A
State Route 329	11/12/2018	39.401295	-81.928980	16.3	181112-329-SL-103	8	5,800	< 1,300	N/A	N/A	N/A	N/A
State Route 339	11/13/2018	39.529836	-81.653900	18.0	181113-339-SL-002	8	1,300	< 1,200	N/A	N/A	N/A	N/A
State Route 248	11/13/2018	39.087553	-81.924699	18.4	181113-248-SL-207	6	660	< 1,200	N/A	N/A	N/A	N/A
State Route 690	11/12/2018	39.382229	-81.991314	18.6	181112-690-SL-003	6	850	< 1,200	N/A	N/A	N/A	N/A
State Route 681	11/13/2018	39.148619	-82.009908	19.8	181113-681-SL-216	6	3,900	< 1,300	N/A	N/A	N/A	N/A

Table 2. PFOA and GenX concentrations in soils

State land or Route	Date	GPS coordinates		Distance from facility (miles)	Shallow soils				Deep soils			
					Sample #	Depth (in)	PFOA (ng/kg)	GenX (ng/kg)	Sample	Depth (in)	PFOA (ng/kg)	GenX (ng/kg)
State Route 124	11/13/2018	38.989386	-81.780092	20.2	181113-124-SL-203	6	760	< 1,100	N/A	N/A	N/A	N/A
State Route 26	11/12/2018	39.436002	-81.358442	20.5	181112-026-SL-002	6	1,600	< 1,200	N/A	N/A	N/A	N/A
State Route 33	11/13/2018	39.029814	-81.941174	21.9	181113-033-SL-204	6	< 210	< 1,200	N/A	N/A	N/A	N/A
Veto Lake Wildlife Area	11/15/2018	39.340276	-81.657260	4.9	181115-VLW-SL-004	6	6,300	< 1,200	181115-VLW-SL-005	27.5	11,000	< 1,200
Veto Lake Wildlife Area	11/15/2018	39.352295	-81.677765	5.7	181115-VLW-SL-008	6	24,000	< 1,200	181115-VLW-SL-009	49	1,400	< 1,300
Ohio River Lock and Dam #18 Wildlife Area	11/15/2018	39.333861	-81.560465	7.6	181115-O18-SL-104	12	5,500	< 1,100	181115-O18-SL-105	30	1,300	< 1,100
Boord State Nature Preserve	11/13/2018	39.393591	-81.745857	9.3	181113-BNP-SL-006 ^a	8	16,000	< 1,200	N/A	N/A	N/A	N/A
Boord State Nature Preserve	11/13/2018	39.393591	-81.745857	9.3	181113-BNP-SL-009	8	15,000	< 1,200	181113-BNP-SL-010	49	280	< 1,300
Boord State Nature Preserve	11/13/2018	39.394196	-81.748213	9.4	181113-BNP-SL-005	5	7,700	< 1,300	N/A	N/A	N/A	N/A
Acadia Cliffs Wildlife Area	11/15/2018	39.320812	-81.844813	9.8	181115-ACW-SL-006	4	4,800	< 1,300	181115-ACW-SL-007	45	820	< 1,100
Desonier State Nature Preserve	11/13/2018	39.238861	-81.869971	10.7	181113-DNP-SL-006	8	7,000	< 1,200	181113-DNP-SL-007	35	8,600	< 1,300
Desonier State Nature Preserve	11/13/2018	39.236563	-81.868559	10.6	181113-DNP-SL-002	8	3,200	< 1,100	181113-DNP-SL-003	39	1,600	< 1,200
Shade River State Forest (North)	11/14/2018	39.147127	-81.799790	10.8	181114-SRF-SL-001	12	20,000	< 1,300	181114-SRF-SL-002	39	< 220	< 1,300
Shade River State Forest (East)	11/14/2018	39.118753	-81.798247	12.4	181114-SRF-SL-008	8	6,200	< 1,200	181114-SRF-SL-009	42.5	4,600	< 1,200
Shade River State Forest (East)	11/14/2018	39.104023	-81.775157	12.6	181114-SRF-SL-012	10	12,000	< 1,200	181114-SRF-SL-011	29.5	560	< 1,100

Table 2. PFOA and GenX concentrations in soils

State land or Route	Date	GPS coordinates		Distance from facility (miles)	Shallow soils				Deep soils			
					Sample #	Depth (in)	PFOA (ng/kg)	GenX (ng/kg)	Sample	Depth (in)	PFOA (ng/kg)	GenX (ng/kg)
Forked Run State Park	11/14/2018	39.093782	-81.775404	13.3	181114-FRP-SL-123	10	9,800	< 1,100	N/A	N/A	N/A	N/A
Ohio River Access Forked Run WA	11/15/2018	39.081676	-81.783054	14.2	181115-FRW-SL-108	12	5,900	< 1,500	N/A	N/A	N/A	N/A
Ohio River Access Forked Run WA	11/15/2018	39.081676	-81.783054	14.2	181115-FRW-SL-109 ^a	12	6,600	< 1,400	181115-FRW-SL-110	48	1,300	< 1,300
Gifford State Forest	11/14/2018	39.443687	-81.904461	17.2	181114-GSF-SL-005	8	5,200	< 1,300	181114-GSF-SL-006	39	1,300	< 1,100
Gifford State Forest	11/14/2018	39.443598	-81.909946	17.4	181114-GSF-SL-003	8	12,000	< 1,400	181114-GSF-SL-004	27.5	860	< 1,400
Ohio River Lock and Dam #21 Wildlife Area	11/15/2018	39.021861	-81.770484	17.9	181115-O21-SL-113	12	3,900	< 1,200	181115-O21-SL-114	48	< 210	< 1,200
Muskingum Lock and Dam #2	11/13/2018	39.470872	-81.490675	17.0	181113-MD2-SL-118	12	4,000	< 1,200	N/A	N/A	N/A	N/A
Muskingum Lock and Dam #2	11/13/2018	39.470872	-81.490675	17.0	181113-MD2-SL-119 ^a	12	4,000	< 1,100	181113-MD2-SL-120	48	210	< 1,200
Muskingum Lock and Dam #5	11/13/2018	39.536571	-81.720272	18.5	181113-MD5-SL-107	11	1,800	< 1,200	181113-MD5-SL-108	48	< 190	< 1,100
Muskingum Lock and Dam #4	11/13/2018	39.547049	-81.642374	19.2	181113-MD4-SO-109	12	390	< 1,100	181113-MD4-SO-110	18	820	< 1,100
Muskingum Lock and Dam #3	11/13/2018	39.527974	-81.517498	19.7	181113-MD3-SL-115	10	5,700	< 1,200	181113-MD3-SL-116	36	11,000	< 1,200
Strouds Run State Park	11/14/2018	39.336982	-82.015952	18.8	181114-SRP-SL-116	12	1,800	< 1,200	181114-SRP-SL-117	48	< 220	< 1,200
Strouds Run State Park	11/14/2018	39.348704	-82.012914	18.9	181114-SRP-SL-112	12	9,100	< 1,200	181114-SRP-SL-113	48	310	< 1,000
Strouds Run State Park	11/14/2018	39.361603	-82.043879	20.8	181114-SRP-SL-111	10	6,100	< 1,300	N/A	N/A	N/A	N/A

Table 2. PFOA and GenX concentrations in soils

State land or Route	Date	GPS coordinates		Distance from facility (miles)	Shallow soils				Deep soils			
					Sample #	Depth (in)	PFOA (ng/kg)	GenX (ng/kg)	Sample	Depth (in)	PFOA (ng/kg)	GenX (ng/kg)
Shade River State Forest (West)	11/14/2018	39.183402	-82.138453	25.6	181114-SRF-SL-013	6	1,400	< 1,200	181114-SRF-SL-014	31.5	< 210	< 1,200
Burr Oak State Park	11/14/2018	39.527628	-82.032390	26.1	181114-BOP-SL-103	10	3,700	< 1,300	181114-BOP-SL-104	42	470	< 1,100
Jesse Owens State Park	11/13/2018	39.733827	-81.722939	32.1	181113-JOP-SL-104	8	330	< 1,100	181113-JOP-SL-105	12	210	< 1,000

a. Field duplicates.

N/A = Data are not available.

Sample concentrations that are below detection limits are represented by a less-than sign followed by the method detection limit.

Figure 2. PFOA concentrations and sampling locations of shallow and deep soil samples on State Routes and in State lands. The concentric rings show the distance from the Washington Works facility.

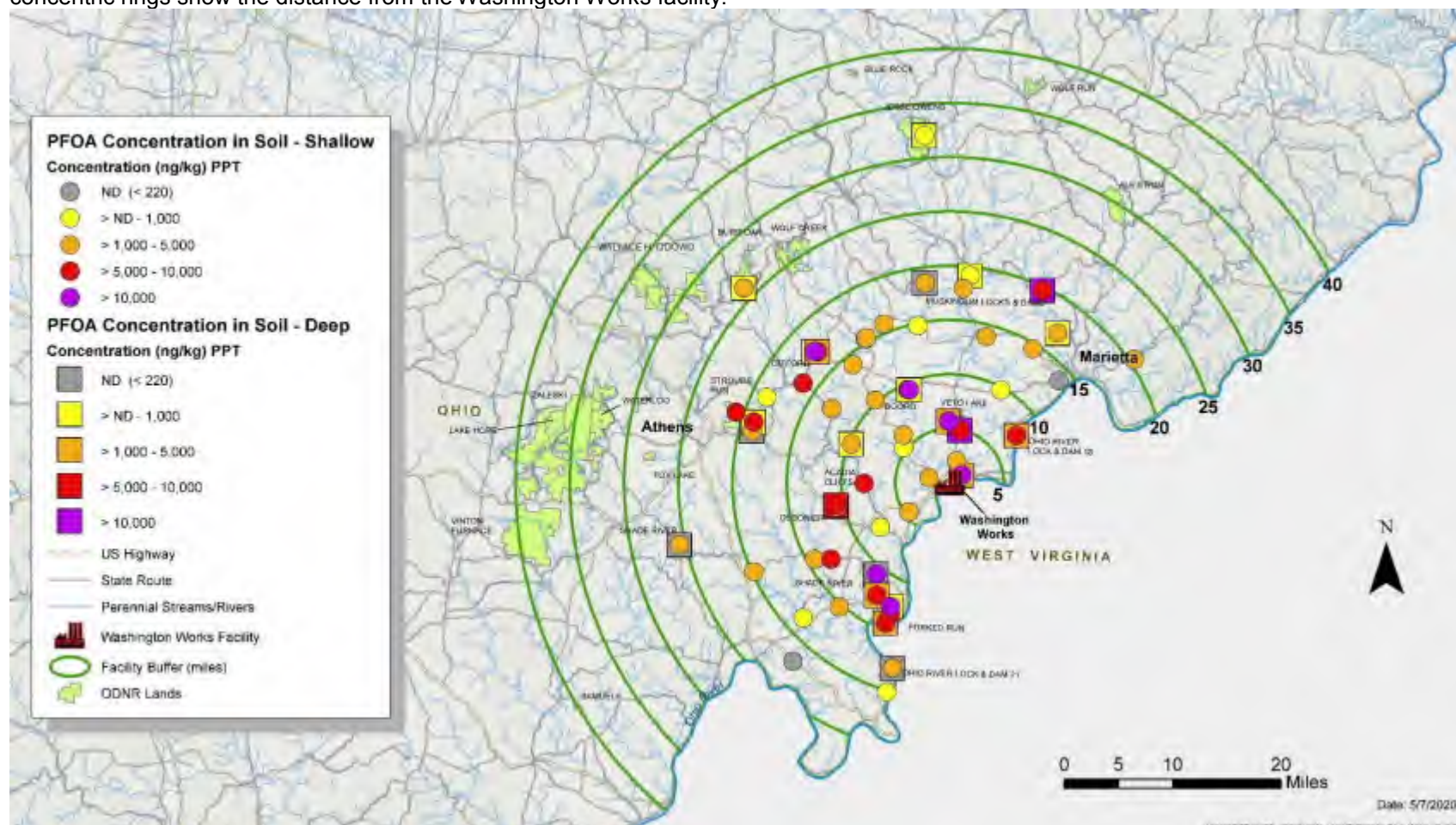


Table 3. PFOA concentration (ng/kg) ranges in shallow and deep soils collected on State lands, with distance from the Washington Works facility

Sample type	Distance from Washington Works facility (miles) ^a	Count (n samples)	Minimum (ng/kg) ^b	Maximum (ng/kg) ^b	Average (ng/kg) ^b
Shallow	0 – < 5	1	6,300	6,300	6,300
	5 – < 10	6	4,800	24,000	12,170
	10 – < 15	8	3,200	20,000	8,840
	15 – < 20	10	390	12,000	4,790
	20 – < 25	1	6,100	6,100	6,100
	25 – < 30	2	1,400	3,700	2,550
	30 – < 35	1	330	330	330
Deep	0 – < 5	1	11,000	11,000	11,000
	5 – < 10	4	280	1,400	950
	10 – < 15	6	< 220	8,600	2,780
	15 – < 20	9	< 220	11,000	1,610
	20 – < 25	0	N/A	N/A	N/A
	25 – < 30	2	< 210	470	240
	30 – < 35	1	210	210	210

a. Distance bins corresponding to the sample location straight-line distance from the Washington Works facility in miles.

b. Samples below detection limits were set to zero for averaging.

N/A = No data available.

State Routes

Shallow Soil Sample Results

PFOA concentrations in shallow soil samples from along State Routes ranged from below detection limits (< 180–210 ng/kg) to 15,000 ng/kg. The highest-observed concentration (15,000 ng/kg) was from a site located just over a mile away from the Washington Works facility on State Route 618. Two samples were below detection limits for PFOA: a sample located approximately 14 miles to the northeast of the Washington Works facility on State Route 550, and one approximately 22 miles to the southwest of the facility along State Route 33 (Table 2; Figure 2). Generally, shallow soil PFOA concentrations increased with increasing proximity to Washington Works (Table 4).

Table 4. PFOA concentration (ng/kg) ranges in shallow and deep soils collected along State Routes, with distance from the Washington Works facility

Sample type	Distance from Washington Works facility (miles) ^a	Count (n samples)	Minimum (ng/kg) ^b	Maximum (ng/kg) ^b	Average (ng/kg) ^b
Shallow	0 – < 5	4	1,200	15,000	5,800
	5 – < 10	6	480	5,100	2,300
	10 – < 15	10	< 180	6,600	2,800
	15 – < 20	9	660	5,800	2,900
	20 – < 25	3	< 210	1,600	790
Deep	0 – < 5	1	4,400	4,400	4,400

a. Distance bins corresponding to the sample location straight-line distance from the Washington Works facility in miles.

b. Samples below detection limits were set to zero for averaging.

N/A = No data available.

The sampling team also collected one deep soil sample just over a mile away from the Washington Works facility, along State Route 618. The PFOA concentration from this sample was 4,400 ng/kg.

5.1.2 GenX Results

This section presents GenX concentrations measured in shallow and deep soil samples on State lands and along State Routes.

State Lands

GenX was not detected in any shallow or deep soil samples taken on public lands (Table 2). GenX detection limits in soils were approximately 1,200 ng/kg, which are higher than the PFOA detection limits.

State Routes

Analytical results indicated one detected value for GenX on State Routes (Figure 3, Table 2). The concentration measured in the detected sample was 2,300 ng/kg. This shallow soil sample was taken just over one mile north of the Washington Works facility on State Route 618. GenX was not detected (at a detection limit of 1,100 ng/kg) in the corresponding deep soil sample at this site.

5.1.3 Soil Physical Characteristics

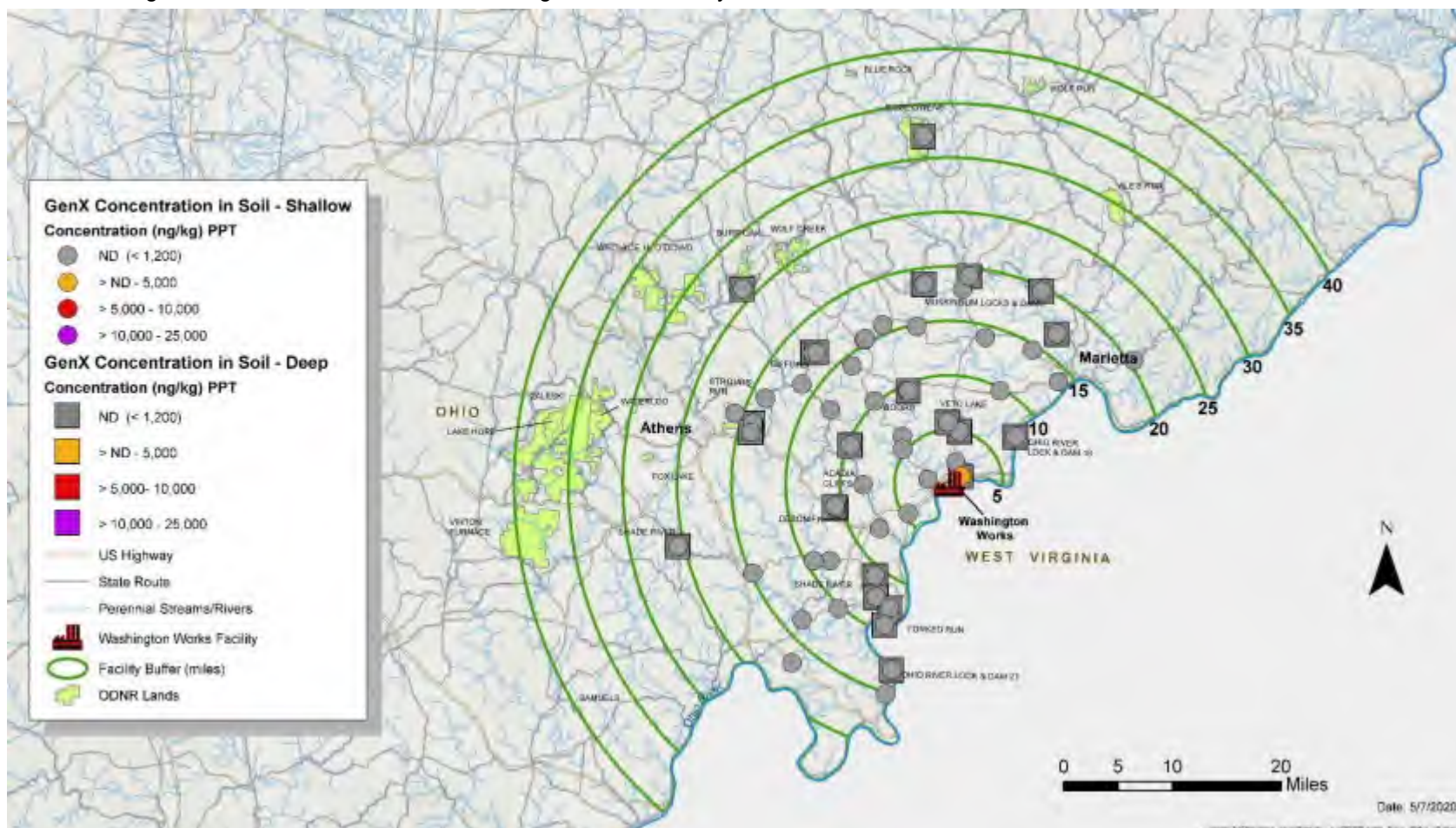
At six locations, shallow (< 1-foot depth) soil samples were collected for the analysis of soil characteristics, including pH, TOC, and grain size. These data are summarized in Table 5, and are included in the 2018 Sampling Database (Appendix G). We grouped the grain size analysis into percentage gravel, sand, silt, and clay based on the Wentworth grade scale in Poppe et al. (2003).

Table 5. Soil characteristics

State land or Route	Date	GPS coordinates		Sample ID	pH	TOC (% dry weight)	Grain size (% by weight)			
		Latitude	Longitude				Gravel	Sand	Silt	Clay
Acadia Cliffs Wildlife Area	11/15/2018	39.320812	-81.844813	181115-ACW-SL-005	5.29	0.33	0.89	26.57	32.59	37.37
Boord State Nature Preserve	11/13/2018	39.393591	-81.745857	181113-BNP-SL-011	4.92	0.16	0.02	9.07	21.08	60.42
Desonier State Nature Preserve	11/13/2018	39.236563	-81.868559	181113-DNP-SL-004	7.15	0.81	5.61	43.74	33.98	11.90
Gifford State Forest	11/14/2018	39.443687	-81.904461	181114-GSF-SL-007	7.05	1.15	24.08	29.38	28.03	14.00
Shade River State Forest	11/14/2018	39.118753	-81.798247	181114-SRF-SL-010	6.69	0.68	2.49	44.12	25.88	17.61
Strouds Run State Park	11/14/2018	39.348704	-82.012914	181114-SRP-SL-114	4.78	0.14	0.03	35.82	34.74	27.34

Note: Grain size percentages may not sum to 100% because of the lower total weight recovered in the laboratory.

Figure 3. GenX concentrations and sampling locations of shallow and deep soil samples on State Routes and in State lands. The concentric rings show the distance from the Washington Works facility.



5.2 Surface Water and Sediment

Surface water samples, including lakes, reservoirs, streams, rivers, and springs, were collected within State lands and along State Routes. Co-located sediment samples were collected at locations within State lands. This section presents PFOA and GenX concentrations measured in surface water and sediment.

5.2.1 PFOA Results

Surface water was collected at 54 locations within the study area. Co-located sediment samples were collected at 16 locations within State lands. Concentrations of PFOA in surface water and sediment are presented for samples collected on State lands, followed by samples collected along State Routes. PFOA and GenX concentrations for all surface water and sediment samples are provided in Table 6.

State Lands

PFOA was detected in all surface water samples collected within State lands (Table 6; Figure 4). Figure 5 presents PFOA surface water concentrations relative to watershed boundaries, showing relative locations along streams and rivers. PFOA concentrations in these samples ranged from 3.2 to 400 ng/L. In general, surface water PFOA concentrations increased with proximity to the Washington Works facility (Table 7). The highest surface water concentration in State lands was seen in Veto Lake (400 ng/L), located five miles to the north of the Washington Works facility in the Veto Lake Wildlife Area (Table 6). The sample with the lowest concentration (3.2 ng/L) was collected from a small stream in Strouds Run State Park, located over 20 miles west of the facility (Table 6). Fourteen surface water samples were collected from streams or rivers within Ohio (inclusive of two field duplicates), seven were collected from lakes or reservoirs, four samples were obtained from the Ohio River (inclusive of one field duplicate), and one sample was collected from a spring. Sample concentrations from streams or rivers (excluding the Ohio River) ranged from 3.2 to 390 ng/L. Surface water samples from the Ohio River had PFOA concentrations ranging from 6.2 to 14 ng/L. Concentrations in lakes or reservoirs ranged from 11 to 400 ng/L, and the PFOA concentration was 3.9 ng/L in the spring. Samples collected from lakes in Burr Oak and Jesse Owens State Parks, 26 miles away and 32 miles away, respectively, were both 11 ng/L.

Co-located sediment samples were collected at 16 surface water sampling locations. PFOA sediment concentrations ranged from below detection limits (< 190–310 ng/kg for non-detect samples) to 5,700 ng/kg. The highest concentrations were 5,700 ng/kg in the Boord State Nature Preserve, 9.4 miles from the Washington Works facility; and 5,300 ng/kg in the Veto Lake Wildlife Area, 6.1 miles from the facility (Table 6, Figure 4).

Table 6. PFOA and GenX concentrations in surface water and sediment

State land or Route	Date	GPS coordinates		Distance from facility (miles)	Surface water type	Surface water			Sediment		
						Sample	PFOA (ng/L)	Gen X (ng/L)	Sample	PFOA (ng/L)	Gen X (ng/L)
State Route 555	11/14/2018	39.277032	-81.711190	2.0	Stream or river	181114-555-SW-209	740	43	N/A	N/A	N/A
State Route 339	11/14/2018	39.297914	-81.663380	2.0	Stream or river	181114-339-SW-213	700	40	N/A	N/A	N/A
State Route 555	11/14/2018	39.277600	-81.711827	2.0	Stream or river	181114-555-SW-208	270	7.3	N/A	N/A	N/A
State Route 555	11/14/2018	39.316684	-81.755578	5.4	Stream or river	181114-555-SW-206	300	10	N/A	N/A	N/A
State Route 555	11/14/2018	39.341191	-81.762533	6.8	Stream or river	181114-555-SW-204	180	3.2	N/A	N/A	N/A
State Route 144	11/12/2018	39.210689	-81.792689	7.5	Stream or river	181112-144-SW-110	18	2.1	N/A	N/A	N/A
State Route 144	11/12/2018	39.267295	-81.821981	7.9	Stream or river	181112-144-SW-108	170	1.7	N/A	N/A	N/A
State Route 550	11/13/2018	39.398361	-81.669703	8.9	Stream or river	181113-550-SW-001	190	6.4	N/A	N/A	N/A
State Route 550	11/12/2018	39.394052	-81.587336	9.8	Stream or river	181112-550-SW-004	280	13	N/A	N/A	N/A
State Route 144	11/12/2018	39.308330	-81.889320	11.8	Stream or river	181112-144-SW-106	5.1	< 0.29	N/A	N/A	N/A
State Route 329	11/12/2018	39.368218	-81.879844	12.9	Stream or river	181112-329-SW-104	40	0.64	N/A	N/A	N/A
State Route 681	11/13/2018	39.166266	-81.877283	13.0	Stream or river	181113-681-SW-210	110	2.2	N/A	N/A	N/A
State Route 681	11/13/2018	39.166266	-81.877283	13.0	Stream or river	181113-681-SW-212 ^a	100	1.8	N/A	N/A	N/A
State Route 550	11/12/2018	39.407318	-81.488023	13.8	Stream or river	181112-550-SW-006	98	2	N/A	N/A	N/A
State Route 676	11/12/2018	39.465664	-81.614035	13.9	Stream or river	181112-676-SW-210	130	3	N/A	N/A	N/A
State Route 550	11/12/2018	39.426284	-81.842614	14.0	Stream or river	181112-550-SW-001	73	0.57	N/A	N/A	N/A
State Route 550	11/12/2018	39.425981	-81.843309	14.0	Stream or river	181112-550-SW-003	47	0.94	N/A	N/A	N/A
State Route 681	11/13/2018	39.166285	-81.905186	14.3	Stream or river	181113-681-SW-213	65	0.88	N/A	N/A	N/A
State Route 676	11/12/2018	39.448689	-81.532867	14.5	Stream or river	181112-676-SW-212	160	3.1	N/A	N/A	N/A
State Route 676	11/12/2018	39.479376	-81.731093	14.8	Stream or river	181112-676-SW-208	27	0.74	N/A	N/A	N/A
State Route 248	11/13/2018	39.103086	-81.862069	15.3	Stream or river	181113-248-SW-208	63	1.2	N/A	N/A	N/A
State Route 676	11/12/2018	39.459556	-81.823223	15.3	Stream or river	181112-676-SW-202	48	0.69	N/A	N/A	N/A
State Route 676	11/12/2018	39.462370	-81.820979	15.4	Stream or river	181112-676-SW-204	34	0.43	N/A	N/A	N/A
State Route 676	11/12/2018	39.482029	-81.790575	15.9	Stream or river	181112-676-SW-206	8.7	< 0.29	N/A	N/A	N/A
State Route 329	11/12/2018	39.402562	-81.929592	16.4	Stream or river	181112-329-SW-102	9.5	< 0.29	N/A	N/A	N/A
State Route 339	11/13/2018	39.529836	-81.653900	18.0	Stream or river	181113-339-SW-001	180	5.9	N/A	N/A	N/A
State Route 248	11/13/2018	39.086997	-81.924747	18.4	Stream or river	181113-248-SW-206	26	0.96	N/A	N/A	N/A
State Route 690	11/12/2018	39.382229	-81.991314	18.6	Stream or river	181112-690-SW-002	4.6	< 0.29	N/A	N/A	N/A
State Route 681	11/13/2018	39.148190	-82.010246	19.9	Stream or river	181113-681-SW-215	18	0.85	N/A	N/A	N/A

Table 6. PFOA and GenX concentrations in surface water and sediment

State land or Route	Date	GPS coordinates		Distance from facility (miles)	Surface water type	Surface water			Sediment		
						Sample	PFOA (ng/L)	Gen X (ng/L)	Sample	PFOA (ng/L)	Gen X (ng/L)
State Route 124	11/13/2018	38.989400	-81.779763	20.2	Stream or river	181113-124-SW-202	22	0.46	N/A	N/A	N/A
State Route 26	11/12/2018	39.435918	-81.358352	20.5	Stream or river	181112-026-SW-001	6.2	< 0.29	N/A	N/A	N/A
State Route 34	11/13/2018	39.019506	-81.940879	22.4	Stream or river	181113-034-SW-205	23	1.4	N/A	N/A	N/A
Veto Lake Wildlife Area	11/15/2018	39.340276	-81.657260	4.9	Lake or reservoir	181115-VLW-SW-001	400	26	181115-VLW-SE-003	910	< 1,200
Veto Lake Wildlife Area	11/15/2018	39.356861	-81.655011	6.1	Lake or reservoir	181115-VLW-SW-006	380	16	181115-VLW-SE-007	5,300	< 2,000
Ohio River Lock and Dam #18 Wildlife Area	11/15/2018	39.334174	-81.560048	7.6	Ohio River	181115-O18-SW-102	14	2.5	181115-O18-SE-103	< 310	< 1,700
Boord State Nature Preserve	11/13/2018	39.394196	-81.748213	9.4	Stream or river	181113-BNP-SW-001	110	4.2	181113-BNP-SE-002	240	< 1,100
Boord State Nature Preserve	11/13/2018	39.394196	-81.748213	9.4	Stream or river	181113-BNP-SW-003 ^a	110	4.4	181113-BNP-SE-004 ^a	< 200	< 1,100
Boord State Nature Preserve	11/13/2018	39.394196	-81.748213	9.4	Stream or river	181113-BNP-SW-007	160	1.7	181113-BNP-SE-008	5,700	< 1,600
Acadia Cliffs Wildlife Area	11/15/2018	39.321003	-81.845521	9.8	Stream or river	181115-ACW-SW-001	390	25	181115-ACW-SE-002	1,500	< 1,100
Desonier State Nature Preserve	11/13/2018	39.236563	-81.868559	10.6	Stream or river	181113-DNP-SW-001	150	2.7	181113-DNP-SE-005	1,100	< 1,400
Shade River State Forest (East)	11/14/2018	39.119347	-81.798245	12.3	Stream or river	181114-SRF-SW-004	86	0.99	181114-SRF-SE-005	530	< 1,000
Shade River State Forest (East)	11/14/2018	39.118947	-81.798867	12.4	Stream or river	181114-SRF-SW-006	84	1.9	181114-SRF-SE-007	< 200	< 1,100
Forked Run State Park	11/14/2018	39.102400	-81.786134	13.0	Lake or reservoir	181114-FRP-SW-118	140	9.7	N/A	N/A	N/A
Forked Run State Park	11/14/2018	39.104185	-81.791538	13.0	Stream or river	181114-FRP-SW-119	50	1.9	181114-FRP-SE-120	1,100	< 1,100
Forked Run State Park	11/14/2018	39.094451	-81.775066	13.2	Lake or reservoir	181114-FRP-SW-121	140	11	181114-FRP-SE-122	< 190	< 1,100

Table 6. PFOA and GenX concentrations in surface water and sediment

State land or Route	Date	GPS coordinates		Distance from facility (miles)	Surface water type	Surface water			Sediment		
						Sample	PFOA (ng/L)	Gen X (ng/L)	Sample	PFOA (ng/L)	Gen X (ng/L)
Ohio River Access Forked Run WA	11/15/2018	39.079077	-81.783644	14.4	Ohio River	181115-FRW-SW-106	7.7	2	N/A	N/A	N/A
Ohio River Access Forked Run WA	11/15/2018	39.079077	-81.783644	14.4	Ohio River	181115-FRW-SW-107 ^a	6.2	2.2	N/A	N/A	N/A
Ohio River Lock and Dam #21 Wildlife Area	11/15/2018	39.022725	-81.769735	17.8	Ohio River	181115-O21-SW-111	11	2.3	181115-O21-SE-112	630	< 1,600
Gifford State Forest	11/14/2018	39.443598	-81.909946	17.4	Stream or river	181114-GSF-SW-001	8.5	0.3	181114-GSF-SE-002	540	< 1,400
Muskingum Lock and Dam #2	11/13/2018	39.470331	-81.490552	17.0	Stream or river	181113-MD2-SW-117	4.8	0.35	N/A	N/A	N/A
Muskingum Lock and Dam #5	11/13/2018	39.537852	-81.721093	18.6	Stream or river	181113-MD5-SW-106	3.7	< 0.29	N/A	N/A	N/A
Muskingum Lock and Dam #3	11/13/2018	39.527830	-81.516151	19.7	Stream or river	181113-MD3-SW-111	4.8	0.34	181113-MD3-SE-112	< 210	< 1,200
Muskingum Lock and Dam #3	11/13/2018	39.527830	-81.516151	19.7	Stream or river	181113-MD3-SW-113 ^a	4.3	0.39	181113-MD3-SE-114 ^a	< 190	< 1,100
Strouds Run State Park	11/14/2018	39.336906	-82.016429	18.9	Lake or reservoir	181114-SRP-SW-115	26	1.7	N/A	N/A	N/A
Strouds Run State Park	11/14/2018	39.361622	-82.044122	20.8	Stream or river	181114-SRP-SW-109	3.2	< 0.29	181114-SRP-SE-110	240	< 1,100
Strouds Run State Park	11/14/2018	39.366058	-82.049014	21.1	Groundwater spring	181114-SRP-SW-108	3.9	< 0.29	N/A	N/A	N/A
Burr Oak State Park	11/14/2018	39.528512	-82.034118	26.2	Lake or reservoir	181114-BOP-SW-102	11	1.1	N/A	N/A	N/A
Jesse Owens State Park	11/13/2018	39.734015	-81.722906	32.1	Lake or reservoir	181113-JOP-SW-102	11	1.9	181113-JOP-SE-103	900	< 1,300

a. Field duplicates.

N/A = No data available.

Sample concentrations that are below detection limits are represented by a less-than sign followed by the method detection limit.

PFOA Concentration in Surface Water
2018 Concentration (ng/L) PPT

- ND (< 0.35)
- > ND - 10
- > 10 - 70
- > 70 - 500
- > 500 - 1,000
- > 1,000

PFOA Concentration in Sediment
Concentration (ng/kg) PPT

- ND (< 200)
- > ND - 1,000
- > 1,000 - 5,000
- > 5,000 - 10,000
- > 10,000

Legend:

- US Highway
- State Route
- Perennial Streams/Rivers
- Washington Works Facility
- Facility Buffer (miles)
- ODNR Lands

The map displays the Washington Works facility in Ohio, surrounded by concentric green circles representing facility buffers at 5-mile intervals (5, 10, 15, 20, 25, 30, 35, 40 miles). The facility is marked with a red industrial icon. Various locations are labeled, including Marietta, Athens, and several rivers and streams such as the Tuscarawas River, Lake Hesperia, and the Ohio River. Data points for PFOA concentration are shown as colored squares and circles corresponding to the legend categories. A scale bar indicates distances from 0 to 20 miles, and a north arrow is present.

Figure 5. PFOA concentrations in surface water samples, with associated watersheds. The concentric rings show the distance from the Washington Works facility. Perennial streams are shown in blue. Watersheds (HUC #10) are identified in different colors on the map.

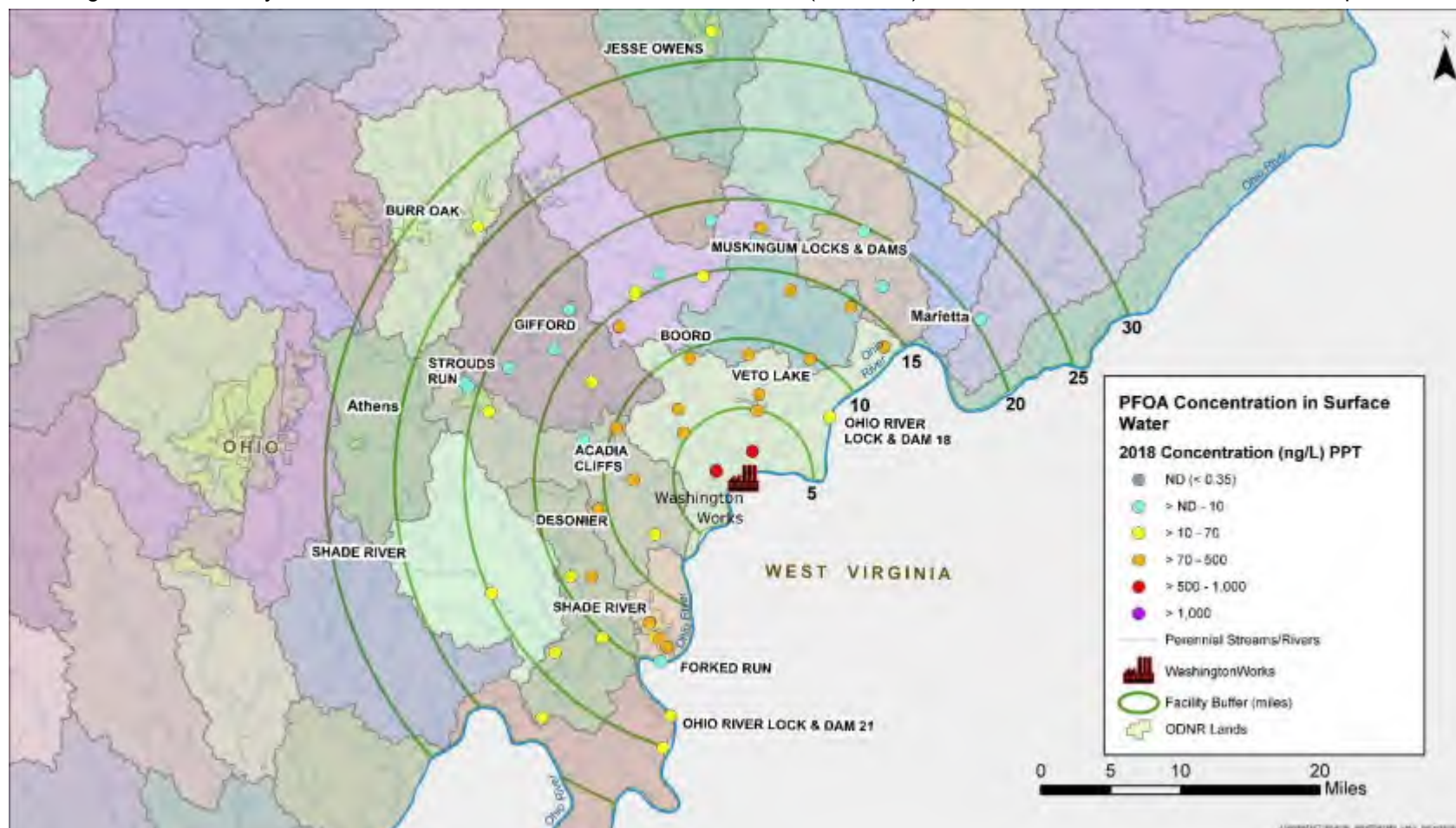


Table 7. Summary of PFOA and GenX concentrations (ng/L) in surface water collected on State lands and along State Routes, with distance from the Washington Works facility

Sample type	Distance from Washington Works facility (miles) ^a	PFOA				GenX			
		Count (n samples)	Minimum (ng/L) ^b	Maximum (ng/L) ^b	Average (ng/L) ^b	Count (n samples)	Minimum (ng/L) ^b	Maximum (ng/L) ^b	Average (ng/L) ^b
State lands	0 – < 5	1	400	400	400	1	26	26	26
	5 – < 10	6	14	390	194	6	1.7	25	8.9
	10 – < 15	8	6.2	150	83	8	0.99	11	4.0
	15 – < 20	7	3.7	26	9.0	7	< 0.29	2.3	0.8
	20 – < 25	2	3.2	3.9	4.0	2	< 0.29	< 0.29	< 0.29
	25 – < 30	1	11	11	11	1	1.1	1.1	1.1
	30 – < 35	1	11	11	11	1	1.9	1.9	1.9
State Routes	0 – < 5	3	270	740	570	3	7.3	43	30
	5 – < 10	6	18	300	190	6	1.7	13	6.1
	10 – < 15	11	5.1	160	78	11	< 0.29	3.1	1.4
	15 – < 20	9	4.6	180	44	9	< 0.29	5.9	1.1
	20 – < 25	3	6.2	23	17	3	< 0.29	1.4	0.6
	25 – < 30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	30 – < 35	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

a. Distance bins corresponding to the sample location straight-line distance from the Washington Works facility in miles.

b. Samples below detection limits were set to zero for averaging.

N/A = No data available.

5.2.2 GenX Results

This section describes GenX analytical results for surface water and sediment. GenX concentrations are presented for samples collected on State lands, followed by samples collected along State Routes. Concentrations in individual surface water and sediment samples are provided in Table 6. Table 7 provides a summary of surface water concentrations, with distance from the Washington Works facility.

State Lands

GenX was detected in most of the 26 surface water samples (i.e., 23 samples, or 88%) collected within State lands. The concentrations of GenX ranged from below detection (< 0.29 ng/L) to 26 ng/L (Table 6, Figure 6). We collected 26 surface water samples, including 14 from rivers and streams within Ohio (inclusive of two field duplicates), 4 from the Ohio River (inclusive of one field duplicate), 7 from lakes and reservoirs, and 1 sample from a groundwater spring. In general, concentrations increased with proximity to the Washington Works facility (Table 7). The highest concentration was 26 ng/L, measured at Veto Lake, located 4.9 miles from Washington Works. GenX was detected in surface water at the farthest location from the Washington Works facility, with a concentration of 1.9 ng/L at Jesse Owens State Park.

GenX was not detected in any sediment samples. Sediment detection limits for GenX were elevated at 1,100 ng/kg or higher.

GenX Concentration in Surface Water
2018 Concentration (ng/L) PPT

- ND
- > ND - 10
- > 10 - 70
- > 70 - 500
- > 500 - 1,000
- > 1,000

GenX Concentration in Sediment
Concentration (ng/kg) PPT

- ND (< 1,100)
- > ND - 5,000
- > 5,000 - 10,000
- > 10,000 - 25,000

US Highway
State Route
Perennial Streams/Rivers
Washington Works Facility
Facility Buffer (miles)
ODNR Lands

Map labels include: BLUE ROCK, WOLF CREEK, WILKES WATCROW, BURNING, WOLF CREEK, MUSKUMBI LOCKS & DAM, Marietta, VICTORY, OHIO RIVER LOCK & DAM (1), Washington Works, WEST VIRGINIA, OHIO, LAKESIDE, WATERLOO, ETRIAN, LA FORT, BURNING, VICTORY, OHIO RIVER LOCK & DAM (2), FORKED RUN, SHADE RUN, FOX LAKE, SHADE RUN, SAMUEL, OHIO RIVER, and various other locations.

Scale: 0 5 10 20 Miles
Date: 5/7/2020

State Routes

GenX was detected in most of the 32 surface water samples (i.e., 27 samples, or 84%) collected along State Routes. All surface water samples along State Routes were collected from streams or rivers (Table 6, Figure 6). GenX concentrations from these samples ranged from below detection limits (< 0.29 ng/L) to 43 ng/L, with concentrations generally increasing with increasing proximity to the Washington Works facility (Table 7). The highest concentration of 43 ng/L was reported in a sample taken 2 miles to the west of Washington Works along State Route 555. The five samples below detection limits were located between 11.8 and 20.5 miles from the facility.

No sediment samples were collected along State Routes.

5.3 Plants

5.3.1 PFOA Results

PFOA was detected in two of the seven plant tissue samples (Table 8). In one black oak tree sample collected 4.9 miles from the Washington Works facility, the PFOA concentration was 3,100 ng/kg on a dry-weight basis. In one cattail sample collected 6.09 miles from the facility, the PFOA concentration was 2,000 ng/kg on a dry-weight basis. We collected both of these samples in the Veto Lake Wildlife Area.

5.3.2 GenX Results

GenX was detected in two of the seven plant samples (Table 8). We collected both of these samples in the Veto Lake Wildlife Area 4.9 miles from the Washington Works facility. In one Christmas fern sample, the concentration of GenX was 4,100 ng/kg on a dry-weight basis. The other sample with a detection of GenX was the same black oak tree leaf sample that had detectable levels of PFOA, with a 3,000 ng/kg concentration of GenX.

Table 8. PFOA and GenX concentrations in plant tissue samples

Location	Distance from Washington Works facility (miles)	Date	Sample type	PFOA (ng/kg dry weight)	GenX (ng/kg dry weight)
Burr Oak	26	11/14/2018	Tree leaf	< 350	$< 1,300$
Burr Oak	26	11/14/2018	Fern	< 350	$< 1,300$
Burr Oak	26	11/14/2018	Grass	< 350	$< 1,300$
Veto Lake	4.9	11/15/2018	Tree leaf	3,100	3,000
Veto Lake	4.9	11/15/2018	Fern	< 350	4,100
Veto Lake	4.9	11/15/2018	Grass	< 350	$< 1,300$
Veto Lake	6.1	11/15/2018	Cattail	2,000/1,900 ^a	$< 1,300$

a. Laboratory duplicate.

5.4 Fish

ODNR collected three largemouth bass from Veto Lake as part of routine fish monitoring. These fish were sent to ALS in Kelso, Washington, for analysis. Liver and fillets were analyzed for PFOA and GenX by ALS.

5.4.1 PFOA Results

The concentration of PFOA in fish tissue samples ranged from 2,600 to 9,100 ng/kg on a dry-weight basis (Table 9).

Table 9. Veto Lake largemouth bass PFOA and GenX concentrations

Fish ID	Length (mm)	Weight (g)	Length (in)	Weight (lbs)	Age (years)	PFOA liver (ng/kg dry wt)	PFOA fillet (ng/kg dry wt)	GenX liver (ng/kg dry wt)	GenX fillet (ng/kg dry wt)
61	547	2,906	21.5	6.41	13	6,100/4,400 ^a	960	< 1,300	< 1,300
58	347	655	13.7	1.44	5	2,600	440	< 1,300	< 1,300
51	181	68	7.1	0.15	2	9,100	1,200	< 12,000	< 1,300

a. Laboratory duplicate.

5.4.2 GenX Results

GenX was not detected in liver or fillets of the three fish. Detection limits were typically 1,300 ng/kg (Table 9).

5.5 Quality Assurance

QA/QC procedures were conducted in accordance with the QAPP, contained as Appendix A of the SAP (Abt, 2018). In addition, ALS analytical laboratory operates within a written Quality Assurance Plan that meets or exceeds the requirements for QA/QC activities required by the U.S. Environmental Protection Agency (EPA).

During the study, 11 field blanks and 3 equipment rinsate blanks were submitted. No target analytes were detected in any of these blanks. In addition, the following field duplicates were submitted: four surface water, four soil, and two sediment samples. All field duplicates met the acceptance criteria.¹

5.6 Data Validation

Data were validated to EPA Stage 4 validation level by EcoChem, Inc. The data validation report is contained in Appendix C, and the EDDs with validation qualifiers are provided electronically in Appendix E. Validated data with final data validation qualifiers are provided in the database proved electronically in Appendix G. The data validation report states that “All data, as qualified, are acceptable for use.”

References

Abt. 2018. Ohio Per- and Polyfluoroalkyl Substances Field Sampling 2018 Sampling and Analysis Plan. Prepared for Kelley Drye & Warren by Abt Associates, Boulder, CO. November 9.

Poppe, L.J., V.F. Paskevich, S.J. Williams, M.E. Hastings, J.T. Kelley, D.F. Belknap, L.G. Ward, D.M. FitzGerald, and P.F. Larsen. 2003. Surficial Sediment Data from the Gulf of Maine, Georges Bank, and Vicinity: A GIS Compilation. U.S. Geological Survey Open-File Report 03-001. Wentworth grad scale. Available: <https://pubs.usgs.gov/of/2003/of03-001/html/docs/images/chart.pdf>. Accessed 5/30/2019.

1. Samples 181113-BNP-SL-005 and 181113-BNP-SL-006, collected at separate sampling sites, were mistakenly identified as duplicate samples for the data validation report. This does not affect the validity or usability of these results.